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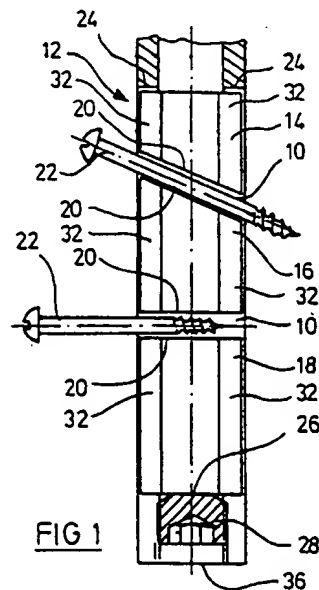
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## (54) A locking marrow nail with adjustable openings for locking screws

(57) A locking nail for placing in the marrow space of tubular bones for the care of bone fractures, with an elongate, essentially cylindrical shank with a number of essentially radial openings for accommodating locking screws. At least one radial, elongate opening extends in the longitudinal direction of the shank and at least two sliding blocks are unrotatably guided within the shank and are secured against a movement away from one another so that at least one opening at an angle to the longitudinal direction is formed from at least one intermediate space between the sliding blocks. This opening is aligned to the elongate opening for accommodating a locking screw.



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## Description

The invention relates to a locking nail corresponding to the preamble of claim 1.

Marrow nails and special locking nails are known aids for osteosynthesis, which are introduced into the marrow space of the damaged bone in order mechanically bridge the bone lesion. With locking nails, locking screws which are mounted transversely through the bone and through the locking nail serve to secure the connection between the bone and locking nail against displacement in the direction of the bone axis as well as against rotation about the bone axis.

With usual locking nails up to now, locking screws are placed in discrete openings, they are arranged essentially radially in the locking nail, on the proximal thigh e.g. also at an inclined angle to the shank axis, but in each case with respect to the length of the shank as well as with respect to the angle to the shank, they are not adjustably arranged.

Due to the individual anatomical or pathological situation with various patients, in many cases it would be advantageous to deviate from the position or the angle of the opening for a locking screw and to place a locking screw elsewhere than is determined by the opening.

Accordingly this invention achieves the object of being able to adjust the openings on locking nails for the locking screws according to position and angle, in order to adapt them to the individual situation concerning different patients, without having to prepare a sortiment of complicated and expensively manufactured locking nails with differing arrangements of the openings for the locking screws.

This object is achieved with the present invention by those features formulated in claim 1.

With the help of the present invention a locking nail may be adapted before implantation to the individual anatomical or pathological situation of a patient in that for the locking screws which are to run through the locking nail at a certain position and a certain angle corresponding to this individual situation, openings are placed and adjusted at a suitable position and a suitable angle.

The locking nail according to the invention is distinguished by the fact that in at least one region of the locking nail in which locking screws are to be placed, an elongate opening radially passing through the shank of the locking nail extends in the longitudinal direction of the shank, and in which at least two sliding blocks are unrotatably guided and are secured against movement from one another. For accommodating a locking screw an opening is formed from at least one intermediate space between the sliding blocks, which is aligned to the elongate opening, so that a radially passing through opening arises for a locking screw. In a preferred embodiment of the invention the sliding surfaces of the sliding blocks, which are aligned to the intermediate space and limit the intermediate space, are concave in

order to adapt themselves to the cylindrical form of the locking screws placed in this opening. The sliding blocks are guided within the shank in the elongate opening preferably by way of a positive fit. In a preferred formation of the invention they comprise radial projections which engage into the elongate opening and which essentially occludingly fill in these openings with the outer contour. Also in the longitudinal direction of the shank the elongate opening is essentially filled in by any number of sliding blocks, which are secured from their movement away from one another for example by a closure at the end of the elongate opening. In a preferred formation of the invention the closure is formed by a closure screw which also may be employed for adjusting the width of the intermediate spaces between the sliding blocks for the flush accommodation of locking screws of differing diameters; the closure screw occludes an opening, axial with respect to the shank, of the elongate opening at the end of the locking nail, wherein the elongate opening up towards this end extends over preferably a third of the length of the locking nail. At the same time the elongate opening may be located at the proximal and/or distal end of the locking nail. Every end of the locking nail provided with an elongate opening, in this preferred embodiment of the invention may be provided with a ring which surrounds the locking nail in order to prevent the spreading out of the end of the shank. With this the ring leaves the axial opening free for introducing the sliding blocks. At the same time each elongate opening, with respect to the manufacture may be preferably formed as a slot which extends in the longitudinal direction of the shank and radially passing through up to the end of the locking nail in question, wherein the shank at least in the region of the slot is formed cylindrically hollow so that the sliding blocks may be guided with a positive fit in the hollow cylindrical inner contour of the shank.

By way of the application of differing sliding blocks, any number of openings, various angles of the openings to the longitudinal direction of the shank, as well as various distances between the openings and the end of the locking nail may be arranged. With this each elongate opening is so filled in with a length and angle corresponding to the sliding blocks in the sliding surface that there arises intermediate spaces of a desired number, position and alignment.

A preferred embodiment form of the invention is described in the following by way of the appended drawings in which

Fig. 1 shows a partial cross section in a lateral view through a shank end of a locking nail according to the invention with locking screws;

Fig. 2 shows a partial plan view of the same end of the locking nail without locking screws, with an opened closure;

Fig. 3 shows a cross section through the shank end taken along line A-B in Fig. 2, without sliding blocks;

Fig. 4 shows a plan view of a sliding block in Fig. 2 in the direction of arrow C; and

Fig. 5 shows a three-dimensional part view of the same shank end from Fig. 1 and 2 with an additional ring without locking screws, sliding blocks and closure.

With reference to Fig. 1 and 2 firstly in Fig. 2 two openings 10 in the end of a shank 12 of a locking nail are to be seen, which are formed from the intermediate spaces between three sliding blocks 14, 16 and 18. The sliding surfaces 20 which are aligned towards the openings 10 and limit these, are concave. Fig. 1 shows in the openings 10 accommodated locking screws 22 which are guided in their direction by the sliding surfaces 20 of the sliding blocks 14, 16 and 18. The distances of the openings 10 and thus of the locking screws 22 to one another as well as to the end of the locking nail is fixed by the length of the sliding blocks 14, 16 and 18. The angle of the openings 10 or of the locking screws 22 is determined by the angle of the sliding surfaces 20. With this the sliding blocks are secured against movement away from one another by stops 24 and by an adjustable stop of a closure screw 28.

With reference to Fig. 3 and 4, in Fig. 3 the hollow cylindrical shape of the shank 12 can be seen, in whose radially passing through, elongate axial opening 30 the radial projections 32 of the sliding blocks 14, 16 or 18 are accommodated and the sliding blocks are thus unrotatably guided by way of a positive fit.

Again referring to Fig. 1 and 2 the elongate opening 30 extends from the stops 24 in the longitudinal direction of the shank up to its end 36. With this Fig. 1 shows that the radial projections 32 of the sliding blocks 14, 16 and 18 essentially occlude with the outer contour of the shank 12. The elongate opening 30 is essentially filled in by the sliding blocks 14, 16 and 18 in the longitudinal direction of the shank 12. The width of the intermediate spaces between the sliding blocks 14, 16 and 18 may be adjusted by turning the closure screw 28 upwards or downwards in the longitudinal direction of the shank 12.

Fig. 2 shows that the closure screw 28 is rotated out from the end of the shank 12 so that the sliding blocks 14, 16 and 18 may be exchanged with another set of sliding blocks (not shown) with the same cross section as is shown in Fig. 4. By way of the fact that with the second set of sliding blocks the intermediate spaces between the sliding surfaces are located at a different distance to one another and to the end of the shank 12, and the sliding surfaces are aligned at a different angle to the longitudinal direction of the shank 12, the openings 10 with respect to position and angle in the shank 12 may be adjusted by way of the geometry (length

between the sliding surfaces, angle of the sliding surfaces to the longitudinal axis of the shank) of various sets of sliding blocks.

Fig. 5 shows a ring 34 which surrounds the end of the shank 12 which is provided with an elongate opening 30, in order to prevent the spreading out of the shank end. With this the ring leaves an axial opening 36 free for introducing the sliding blocks 14, 16 and 18 with a cross section profile according to Fig. 4.

#### Claims

1. A locking nail for placing in the marrow space of tubular bones for the care of bone fractures, with an elongate, essentially cylindrical shank (12) with a number of essentially radial openings (10) for accommodating locking screws (22), characterised in that at least one radial, elongate opening (30) extends in the longitudinal direction of the shank (12) and that at least two sliding blocks (14, 16, 18) are unrotatably guided within the shank (12) and are secured against a movement away from one another so that at least one opening (10) at an angle to the longitudinal direction is formed from at least one intermediate space between the sliding blocks (14, 16, 18), wherein this opening (10) is aligned to the elongate opening for accommodating a locking screw.
2. A locking nail according to claim 1, characterised in that the sliding surfaces of the sliding blocks (14, 16, 18), aligned to the intermediate space, are concave.
3. A locking nail according to claim 1 or 2, characterised in that the sliding blocks (14, 16, 18) are so formed within the shank (12) that they are secured against radially falling out of the elongate opening (10) by way of a positive fit.
4. A locking nail according to one of claims 1 to 3, characterised in that the sliding blocks (14, 16, 18) comprise radial projections (32) engaging into the elongate opening which occlude essentially with the outer contour of the shank (12).
5. A locking nail according to one of claims 1 to 4, characterised by a set of exchangeable sliding blocks (14, 16, 18) with a different length in the longitudinal direction of the shank (12) and/or a different angle between the sliding surface (20) and the longitudinal direction of the shank (12).
6. A locking nail according to one of claims 1 to 5, characterised in that the elongate opening (30) is essentially filled in by any number of sliding blocks (14, 16, 18) of the same or different lengths.

7. A locking nail according to one of claims 1 to 6, characterised in that the sliding blocks (14, 16, 18) are secured against a movement away from one another by way of a closure (28) at the end of the locking nail. 5
8. A locking nail according to claim 7, characterised by a closure screw as a closure (28).
9. A locking nail according to one of claims 1 to 8, characterised in that the width of the intermediate space between the sliding blocks (14, 16, 18) can be set by adjusting at least one sliding block by way of an adjustable stop (26). 10 15
10. A locking nail according to one of claims 1 to 9, characterised in that the length of the elongate opening (30) is at least one third of the length of the locking nail. 20
11. A locking nail according to claim one of claims 1 to 10, characterised in that an elongate opening (30) is located at the proximal and/or distal end of the locking nail. 25
12. A locking nail according to one of claims 1 to 11, characterised in that the elongate opening (30) at at least one end of the locking nail is formed by a slot which extends in the longitudinal direction of the shank (12) and extends radially passing through to the shank up to the mentioned end, wherein the shank at least in the region of the slot is formed cylindrically hollow and wherein the sliding blocks (14, 16, 18) are guided in the cylindrically hollow shank (12) by a positive fit. 30 35
13. A locking nail according to claim 12, characterised by a ring (30) at the end of the locking nail provided with a slot, wherein the ring surrounds the locking nail and leaves free an axial opening (36) for introducing the sliding blocks (14, 16, 18). 40 45 50 55

